IMPLEMENTATION REVIEW AND STATUS REPORT

OF

PEFCO FOUNDRIES
(UNIT OF KORES INDIA LTD.)
PUNE

Presented by

P.R.B.GUPTHA
R.SAKTHIVEL

Tata Energy Research Institute
50/7, Palace Road Bangalore Centre

H.O

Darbari Seth Block, India Habitat Centre
Lodi Road, New Delhi 110 003

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TATA ENERGY RESEARCH INSTITUTE
BANGALORE

EXECUTIVE SUMMARY

Executive Summary

1.0 INTRODUCTION:

The Post Audit Review was conducted during November 1997 to assess the implementation status and actual energy savings of energy conservation measures suggested during detailed energy audit.

Total annual energy consumption of the plant is about 118 lakh kWh(i.e, Rs 422.00 lakh). The induction furnaces consume about 80% of the total plant consumption which are being operated very efficiently. Other equipment and sections consume about 20 % the total plant energy consumption. The implementation of suggested measures resulted in saving about 22% of the energy consumption of these equipment/sections. Total annual energy savings achieved are 4.30 lakh kWh amounting Rs. 15.23 lakhs.

2.0 REVIEW OF DEA AND IMPLEMENTATION STATUS:

The post audit review of DEA conducted during October 1997 indicated that commendable improvement in energy savings and high degree of awareness about the energy conservation among the plant management. The actual energy savings from the implemented measures are higher than estimated savings. The areas where maximum savings were achieved are:

- Indirect arc furnaces
- Heat treatment furnaces
- Transformer load management.

CONCLUSION

The post audit review for the energy audit conducted during November 1997 at Pefco Foundries, Pune has been discussed in detail. It is observed that saving about 22% of the energy consumed by the plant (excluding induction furnaces) have been achieved by implementing the audit recommendations.

Energy Conservation Measure	Anticipated Annual Savings			Actual Annual Savings		
	kWh	Rs Lakh	Investment Rs Lakh	kWh	Rs Lakh	Investment Rs Lakh
Transformer load management	16080	0.47	0.86	59340	2.10	0.27
Use of energy efficient motors	11390	0.33	0.64	4820	0.17	0.00
Installation of soft starters to the motors	3170	0.09	0.45	Not implemented due to high payback period		
Conversion into star mode of under loaded motors	1360	0.04	00	Under consideration with auto controllers and awaiting for reliable supplier		
Replacement of refractory with ceramic fibre in heat treatment furnaces	29300	0.85	0.40	97100	3.50	4.00
Improvement in Loading of heat treatment furnaces	99900	2.92	0.00	97800	3.50	0.00
Replacement of Indirect arc furnaces with induction furnaces	150500	3.91	17.50	150000	5.36	10.00
Reduction in distribution losses in Indirect arc furnaces	20700	0.53	0.20	20300	0.60	0.00
Use of single stage compressor exclusively for cleaning operation	151200	4.41	0.50	The quantify of air required is very low		
Installation of Voltage stabilisers of lighting	10270	0.30	0.50	Under Implementation		
	493870	**13.85**	**21.05**	**429360**	**15.23**	**14.27**

TATA ENERGY RESEARCH INSTITUTE
BANGALORE

MAIN REPORT

IMPLEMENTATION REVIEW & STATUS REPORT

OF

DETAILED ENERGY AUDIT STUDY OF

PEFCO FOUNDRIES, PUNE

1.0 INTRODUCTION

Pefco foundry is leading manufacturer of various SG and MS.Alloy casings for automobile industry and railways. The plant has various major energy consuming equipment's such as:

- *INDUCTION FURNACES:*

Furnace	Capacity	Frequency
Inductotherm	1000 kW/750 kg	-
Electrotherm	450 kW/500 kg	400
Electrotherm	350kW/500 kg	400
Inductotherm	125kW/50kg or 100kg	500

- *ANNEALING FURNACES :*

Three electrical resistance heated annealing furnaces for heat treatment of automobile components.

- *ARC FURNACES (DIRECT AND INDIRECT ARC FURNACES):*

Indirect arc furnaces were replaced with one induction furnace after the detailed energy audit.

- *RECIPROCATING COMPRESSORS:*

Compressor	Capacity, cfm	Rated kW
Single stage vertical - IR make	140	30
Single stage vertical - IR make	140	30
Single stage vertical - IR make	140	30
Two stage horizontal vertical - IR make	550	90

- *ELECTRICAL SYSTEMS :*

Pefco has four transformers of capacity 1150, 800,800 and 1000 kVA respectively.

- *ELECTRIC DRIVES :*

Electric motors of 1kW to 100 kW are employed for belt conveyers, air compressors, cooling water pumps, centrifugal liners, machine tools, blowers and jobbing machines.

- *COOLING TOWERS:*

Pefco has three cooling towers: two of natural draft and one of induced draft type catering the cooling water requirement.

- *LIGHTING:*

The connected lighting load of the plant is about 2% of the plant load. Plant has made use of GLS, FT and HPMV.

Detailed energy audit was conducted in the above sections during October 1995 by a team of Consulting engineers from TERI to arrive at various energy conservation measures.

Post audit review was conducted during November 1997 as part of continuing activity to closely review the progress achieved and also to analyse the extent of energy savings realised by the plant.

The detailed review of Energy Audit conducted by TERI was carried out to assess the:

- *Extent of progress achieved in implementation of recommendation.*
- *Impact on the energy bill.*

- *Actual saving potential and techno-economics.*
- *Increase in the awareness of energy conservation in the plant.*
- *Reasons and problems associated for partial and non-implementation of the proposals.*
- *Other benefits achieved (apart from the energy savings) such as improvement in productivity, working conditions, flexibility in operation, control operations, etc.*
- *Revised techno-economics of non implemented measures.*
- *Reliability of the energy saving retrofits incorporated.*
- *Time required for implementation of the measures.*
- *Implementation assistance required for non implemented measures.*
- *Management and operators views about the recommendations.*
- *Improvement required in the report presentation.*

Several discussions were held at the plant office with the management and plant operating personnel . Detailed measurements were made by using sophisticated portable instruments to assess the actual energy saving potential.

2.0 ENERGY CONSUMPTION PROFILE

2.1 *MAJOR SOURCES OF ENERGY AND CONSUMPTION DATA*

Electricity is the major sources of energy to the plant. Electricity is used for melting applications, heat treatment, operating electric drives, lighting etc. Little quantities of HSD is used for ladle preheating.

Electrical energy consumption and production for the last five years

Year	Production MT		Energy in Lakh kWh		
	Finished	As Casted	Induction furnace	Others	Total
1992-93	1829.1	3410	25.94	15.67	41.61
1993-94	3015.9	5197	40.61	11.26	51.87
1994-95	4177.7	7066	54.83	11.18	66.01
1995-96	5423	9144	66.78	16.06	82.85
1996-97	6050	10573	73.47	19.03	93.17

The total energy consumption in last five years, it has been increased due to increase in production and addition of auxiliary equipment. It can be seen that induction furnaces consume 80% of total energy and these are being operated very efficiently.

Specific energy Consumption

Year	Finished	Total Energy lakh kWh	kW/MT
1992-93	1829.1	41.61	2275
1993-94	3015.9	51.87	1720
1994-95	4177.7	66.01	1580
1995-96	5423	82.85	1525
1996-97	6050	93.17	1540

It can be observed that specific energy consumption in induction furnaces has been reduced over the period of time. Though the specific energy consumption of finished product indicates the saving potential, in actual practice the energy savings much higher due to non accounting of the total energy consumption which include annealing furnaces, small induction furnace where the saving potential is above 40%.

2.2 *ENERGY COST*

The following gives comparison tariff and demand for the last four years

Particulars	Contract Demand, kVA	Demand charges, Rs/kVA	Unit Charges, Rs/kWh
1994-95	1645	95	2.42
1995-96	2800	125	2.65
1996-97	2800	170	3.59
1997-98	2800	170	3.59
% Variation form base year i.e.,(1995-96)	**0**	36%	**35.47%**

It is seen from the above table that from the period of conducting the detailed energy audit the cost of electricity purchased has shown significant increase and hence the cost of projected savings are also expected to raise in proportion. However, the cost of investment projected for various proposals not assuming, the proportional increase in the pay back period will automatically come down with increase in tariff on electricity and fuels.

2.3 *ENERGY MONITORING SYSTEMS*

Energy consumption is being monitored periodically and the consumption profile is being maintained and reviewed thoroughly. Consumption being monitored based on

- *Unit wise*
- *shop wise*
- *Equipment wise*
- *Production wise*

For the purpose of the monitoring, plant has installed 26 energy meters at different locations. At the receiving end MSEB have replaced the meter with digital static electronic meter.

The present of energy monitoring is found satisfactory and suggested to continue the same.

3.0 REVIEW OF RECOMMENDATION OF DETAILED ENERGY AUDIT AND IMPLEMENTATION STATUS :

3.1 *METHODOLOGY*

TERI team visited the plant and discussed with plant personnel about the implementation status. During the visit each and every recommendation was reviewed for the

- *Actual savings*
- *Investment incurred*
- *Related problems*
- *Productivity improvement*
- *Operational features after implementation*
- *Retrofits incorporated*
- *Scope for further energy savings*

Several discussions were held at the plant office with the management and plant operating personnel . Detailed measurements were made by using sophisticated portable instruments to assess the actual energy saving potential.

3.2 STATUS OF IMPLEMENTATION

During the post audit review detailed measurements were made to quantify the actual saving potential. The following table gives the brief status of energy saving measures suggested in the detailed energy audit report.

Status of Implementation

Energy Conservation Measure	Status	Remarks
Transformer load management	Implemented	-
Use of energy efficient motor	Modified and implemented partially	Due to change in the process reduction in hours of operation
Installation of soft starters	Not implemented	Due to high payback period
Conversion in to star mode of under- loaded motors	Under implementation	Awaiting for the reliable supplier
Replacement of refractory with ceramic fibre in heat treatment furnaces	Implemented	-
Improvement in Loading of heat treatment furnaces	Implemented	-
Replacement of Indirect arc furnaces with induction furnaces	Implemented	-
Reduction in distribution losses in Indirect arc furnaces	Implemented	-
Use of single stage compressor for cleaning applications	Not applicable for present conditions	The quantity of air required is very low
Installation of voltage stabilisers for lighting	Under implementation	Awaiting for the retrofit procurement

The following gives summary of the implementation status :

Particulars	Status	% Status
No of measures suggested	10	100
No of measures implemented	5	50
No of measures under implementation	2	20
No of measures implemented partially	1	10
No of measures not applicable for present conditions	1	10
No of measures not implemented due to economics	1	10

It can be seen that above 80% of recommended measures were implemented/under implementation. This indicates the high degree of awareness about the energy conservation among the plant management. During the review it was observed that plant personnel have analysed each recommendation given in the detailed energy audit for implementation and all possible & feasible measures have been implemented.

3.3. COMPARATIVE ANALYSIS BETWEEN THE ANTICIPATED ENERGY SAVING AND ACTUAL SAVINGS

Energy Conservation Measure	Anticipated Annual Savings			Actual Annual Savings		
	kWh	Rs Lakh	Investment Rs Lakh	kWh	Rs Lakh	Investment Rs Lakh
Transformer load management	16080	0.47	0.86	59340	2.10	0.27
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Use of single stage compressor exclusively for cleaning operation	151200	4.41	0.50	00	0.00	0.00
	483600	**13.55**	**20.55**	**429360**	**15.23**	**14.27**

3.4 *IMPACT ON ENERGY BILL*

Total Annual Energy Savings	: 4.30 lakh kWh
Total Annual Cost Savings	: Rs. 15.23 lakh
Total Investment incurred	: Rs. 14.30 lakh
Simple Payback period	: 11 months

About 80% of the total energy consumption accounts for induction furnaces and these are operated at the lowest specific energy consumption of about 670 kWh /MT. Other equipment and sections consume about 20% of the total plant consumption

Impact on Energy Consumption excluding induction furnaces

Energy Consumption	: 22.00 lakh kWh/yr
Energy Bill	: Rs.76.00 lakh/yr
% Savings on Energy	: 20%

Impact on total plant consumption

Total Annual Energy Consumption	: 118 lakh kWh
Total Annual Energy Bill	: Rs. 422.00 lakh
% Savings on Energy	: 4%

4.0 DETAILED ANALYSIS OF RECOMMENDATIONS AND IMPLEMENTATION STATUS

RECOMMENDATION : Transformer Load Management - Redistribution of load in Transformer 3 & 4

Status : Fully Implemented

Back Ground :

Pefco Foundry receives electricity from MSEB at 22 kV. The major loads are furnaces, motor driven auxiliaries and other machines. Two distribution transformers supply power to furnaces, utilities and drives. Two other furnace transformers exclusively supply power to 800 kW & 450 kW induction furnaces. The audit team found that Transformer 3 was loaded 37.5% & Transformer 4 was loaded 95% ,which is not economical loading. To reduce the losses the audit proposed some loads be shifted from Transformer 4 to Transformer 3.

Action taken by the plant.

Pefco management have taken up the proposal is right earnest and have shifted the compressor load from Transformer 4 to Transformer 3. More over they have removed Direct & Indirect Arc Furnace having a load of 650 kVA and replaced them with Induction furnace of capacity 140 kVA.. Plant management also have taken the help of external consultants in the transformer field to examine and calculate the losses in the transformer.

Name of the consultant : Rakesh Transformer Industries Private Ltd., Pune.

Investment incurred : Rs 12000 /- for transformer checking. Other charges Rs 15000/-

Actual Energy Savings

The loading of both transformers were measured during the post audit review & the savings were calculated which are shown in appendix -1. The following table gives the summary of actual energy saved and cost benefits achieved.

Economics:

Total Actual Energy saved	: 59341 kWh
Energy savings (@ Rs 3.59/kWh)	: Rs. 2.10 lakh
Investment incurred	: Rs. 27000
Payback period	: 1.5 months

Comparative statement of anticipated & actual savings :

Particulars	Unit	Trans # 3	Trans # 4	Total
Rating	kVA	800	1000	
Estimated values During DEA				
Calculated losses before load shifting	kWh	19378	73539	92917
Estimated losses after load shifting	kWh	30015	46644	76659
Energy savings	kWh	- 10637	26895	16258
Cost savings (Rs2.65/kWh)	Rs	-28188	71272	43084
Cost savings per year (Rs3.59/kWh)	Rs	-38187	96553	58366
After Implementation				
Actual Losses after load shifting	kWh	14132	19434	33566
Actual energy saved	kWh	5246	54105	59351
Cost of energy saved (Rs. 3.59/kWh)	Rs	18833	194237	213071

It can be seen that due to load shifting & providing better and efficient furnaces the reduction in transformer losses has been quite substantial, which in turn has resulted in heavy reduction in the pay back period from an estimated period of 1.84 years (22 months) to 0.126 years (1.5 months).

RECOMMENDATION : Use of energy efficient motor

Status : Implemented after modification

Back Ground :

Pefco Foundry has many types of plant equipment - Belt conveyors, Air compressors, Cooling Water Pumps, Centrifugal liners for casting, Jobbing machines etc. These machines use electric motors of various rating between 1.0 hp to 125 hp. The audit team after studying the loading pattern of these motors have recommended the plant management to replace very old & rewound motors with high efficiency motors.

Action taken by the plant.

Pefco management have examined this proposal for replacing of old & rewound motors. The three motors identified for this proposal were studied. The management felt that the above proposal is not economically viable because of high cost of investment. They further examined these motors and took corrective action for better usage of these motors.

SL no	Application	Rating	Action taken by the plant
1	Exhaust Blower	18.5 kW	Change in location of the blower
2	Centrifugal liner	11.0 kW	Reduction in operating hours
3	Sand Mixer	15.0 kW	Change in the process

Actual Energy Savings

The loading of the motors were measured during the post audit review & the calculated savings are shown in the appendix -2. The table gives the actual energy saved.

Economics

Total Actual Energy saved : 4821 kWh.

Cost of Energy saved (Rs 3.59) : Rs. 17307

Investment incurred : Minimal.

Payback period :Immediate.

Comparative statement of anticipated & actual savings.

Drive & Rating	Recommended Action	Modified action taken	Estimated energy savings, kWh/y	Savings Realised , kWh/y	Estimated savings Rs/year.	Cost Savings Realised, Rs/year
Exhaust Blower 18.5 kW	Use of energy efficient motor	Change in location of the blower	5348	4536	19200	16284
Centrifugal liner 11.0 kW	Use of energy efficient motor	Reduction in operating hours	830	-75	2980	-129
Sand Mixer 15.0 kW	Use of energy efficient motor	Change in the process	5212	360	18711	619
Total			**11390**	**4821**	**40891**	**16774**

It can be seen that the recommended proposal of replacing old & rewound motors with energy efficient motor has been modified by the plant management according to the needs and this action has resulted in energy 4821 kWh worth Rs 16774 being saved with out any investment

The recommendation had called for investment of Rs 65000/-

RECOMMENDATION : Installation of soft starter for scrap binding & skip charger machines

Status : Not Implemented

Back Ground :

Pefco Foundry has many types of plant equipment - Belt conveyors, Air compressors, Cooling Water Pumps, Centrifugal liners for casting, Jobbing machines etc. These machines use electric motors of various rating between 1.0 hp to 125 hp. The audit team after studying the loading pattern of these motors have recommended installation of Soft starters for two machines - Scrap binding m/c & Skip charger m/c.

Action taken by the plant.

Pefco management have examined this proposal. The management felt that the above proposal is not economically viable because of high cost of investment and longer pay back period. The payback period for Scrap binding m/c is 3.92 years & Skip charger m/c is 9.1 years. More ever number of hours of operation of these machines has come down , which in turn has increased the pay back period. These have forced the management to drop the above proposal.

Reasons for not implementing the proposal

- *Reduced hours of operation*
- *High cost of investment*
- *Very long payback period*

RECOMMENDATION :Conversion into star mode of under-loaded motors

Status : Not Implemented but under consideration

Back Ground :

Pefco Foundry has many types of plant equipment - Belt conveyors, Air compressors, Cooling Water Pumps, Centrifugal liners for casting, Jobbing machines etc. These machines use electric motors of various rating between 1.0 hp to 125 hp. The audit team after studying the loading pattern of these motors have recommended that motors which are loaded below 30% may run in the star mode to reduce the losses.

Action taken by the plant.

Pefco management have examined this proposal. The management after studying the various product profiles that are produced in the plant felt that the above motors will be loaded more than 30% & the loading pattern will change according to the product.

Revised loading pattern of the suggested motors have been measured and the recorded parameters are given the appendix -3

Reasons for not implementing the proposal

- *Change in product profile*
- *Change in the loading*

TERI during the post audit review examined the loading of these motors. The loading is given in appendix . TERI found that the loading of two motors has increased.

Audit team has given the addresses of suppliers / manufacturers of AUTO DELTA/ STAR converter equipment as implementation assistance. These equipment configure the motor to run in STAR / DELTA mode according to the loading after sensing the loading.

Revised Estimated Savings :

Total energy savings

Motor Drive	Energy savings, kWh/year	cost savings, kWh/year	Investment Rs	Payback period
Sand Cooler, 7.5 kW	792	2800	15000	5.35
Knockout motor, 5.5 kW	180	646	12000	18.6
Alex machine, 3.7 kW	389	1400	10000	7.14
Total	**1361**	**4846**	**37000**	**7.7**

Installation of auto delta-star converter for the above drives may not be feasible at the present operating conditions due to high pay back period.

RECOMMENDATION : Replacement of Refractory with Ceramic Fibre to reduce the surface heat losses

Status : Fully Implemented

Back Ground :

Pefco Foundry has 3 electrical (resistance) heat treatment furnaces (A2, B3 and C1) for annealing application of auto-mobile components. These furnaces were provided with refractory bricks. The measured surface temperatures and estimated surface heat losses during detailed energy audit revealed that the losses are on higher side due to very high temperatures. To reduce the surface losses the audit team had suggested to replace the insulation with ceramic fibre supported by refractory bricks.

Action taken by the plant :

Refractory insulation of two furnaces was replaced with combination of ceramic fibre and refractory while the furnace was completely revamped. During the replacement, resistance heating elements were also replaced. The implementation work was carried out by a local contractor who also supplied the material.

Name of the Contractor : Ceramic Shapes, Pune

Time taken :

- For Furnace B3 and C1 : 2 Weeks each (insulation and heating element replacement.
- For Furnace A2 : 3 months for complete revamping.

Investment incurred : Rs 4.00 lakh which includes cost of insulation, cost of heating element, complete revamping of one furnace, intelligent PLCs and erection charges.

Actual Energy Savings and other benefits achieved:

Actual surface temperatures were measured after the replacement of the implementation (During post audit review) and actual surface heat losses were estimated. During post audit review the following were observed:

- *Reduction in surface heat losses by 60%.*
- *Reduction in surface temperature upto 40°C.*
- *Reduction in cycle time by 40 %.*
- *Increased productivity by 33%.*
- *Reduction in ambient temperature of furnace surroundings by 5-10°C.*
- *Improvement in working conditions.*
- *Reduction in heat-up time and fast raise of temperature.*
- *Reduction in thermal inertia of the furnace.*

The following table gives the summary of the actual energy savings and other benefits achieved. Detailed analysis is given in the appendix - 4.

Particulars	Units	B3	C1	A2	Total
Surface heat losses before insulation	kCal/h	6600	6600	4504	17704
Surface heat losses after insulation	kCal/h	2589	2235	2462	7286
Reduction in surface heat losses	***kCal/h***	***4011***	***4365***	***2042***	***10418***
Percentage reduction in losses	%	61	66	45	59
Savings in power	kW	4.7	5.1	2.4	12.1
Cycle time before replacing of insulation	h	17.5	17.5	16.0	17.0
Cycle time after insulation	h	11	11	9	10.3
Reduction in cycle time	***h***	***6.5***	***6.5***	***7***	***6.7***
Savings due to reduction in surface losses	kWh/year	24485	26647	11397	62530
Savings due to reduction in cycle time	kWh/year	13642	13461	7479	34582
Total energy savings	***kWh/year***	***38127***	***40108***	***18877***	***97112***
Annual cost savings	***Rs***	***137258***	***144389***	***67767***	***349414***
Investment Required	Rs	100000	100000	200000	400000
Payback period	***years***	***0.73***	***0.69***	***2.95***	***1.14***

Economics :

Total actual energy savings : 97110 kWh

Actual annual cost savings : Rs. 3.50 lakh

Investment incurred : Rs. 4.00 lakh

Payback period : Rs. 1.14 years

Comparative statement of anticipated and actual energy savings:

Particulars	Units	B3	C1	A2	Total
Estimated surface heat losses after Insulation	kCal/h	2458	2458	2462	7378
Actual surface heat losses after insulation	kCal/h	2589	2235	2462	7286
Estimated saving in power	kW	3.9	3.9	1.89	9.69
Actual savings in power	kW	4.7	5.1	2.4	12.1
Estimated savings	kWh/year	20265	20265	9072	49602
Actual total energy savings	kWh/year	38127	40108	18877	97112

It can be seen that though the estimated and actual heat savings are almost same higher energy and cost savings (in excess of 100% of anticipated savings) were realised due to additional benefits of the measure such as :

- *reduction in cycle time due to reduction in thermal mass by replacement.*
- *while estimating energy savings allowance factor of 20% was given.*
- *replacement of old heaters.*
- *proper replacement of insulation.*
- *fast rate of heat pickup.*
- *increased productivity.*

RECOMMENDATION : Improvement in Loading of Heat Treatment Furnaces

Status : Fully Implemented

Back Ground :

Three 3 electrical (resistance) heat treatment furnaces (A2, B3 and C1) are used for the annealing application of auto-mobile components. During the energy Audit study conducted in October,1997, it was observed that these furnaces were loaded about 100 pieces of automobile components (Inlet tube-1.7 kg each and exhaust tube -1.5 kg). The audit team had suggested for better insulation by providing the ceramic fibre by which the thermal inertia of the furnace and surface heat losses can be reduced. Due to reduction in losses and increase in working area of the furnace, It is also suggested that the furnace loading should be increased atleast by 75%.

Action taken by the plant :

Refractory insulation of two furnaces was replaced with combination of ceramic fibre & refractory and the furnace loading was improved by 50% in furnace B3 and C1 while in case of furnace was loading was improved by 300% due to complete revamp of this furnace.

Investment incurred : Nil, since the cost of insulation was already considered in the measure " *Replacement of refractory with ceramic fibre* ".

Actual Energy Savings and other benefits achieved:

Actual loading of the furnaces was observed during the post audit review and found the loading was improved by 50% in two furnaces and 300% in one furnace. The following table gives the summary of the actual energy savings.

Energy Savings by Improving the Loading of the Furnaces:

Parameters	Units	A2		B3		C1	
		Before	After	Before	After	Before	After
Furnace loading	No of pieces	100	400	100	150	100	150
Approximate weight	kg	160	640	160	240	160	240
Improvement in loading	*No of pieces*		*300*		*50*		*50*
	kg		480		80		80
	%		300		50		50
No of cycles per month	no	37.5	9.4	34	22.7	35	23.3
Energy consumption per cycle	*kWh*	*142*	*364*	*191*	*160*	*203*	*160*
Monthly energy consumption	kWh	5325	3413	6494	3627	7105	3733
Energy Savings per month	kWh		1913		2867		3372
Energy saving per year	kWh		22950		34408		40460
Cost savings	Rs/year		82390		123525		145251
Total annual energy savings	*kWh*	*97818*					
Total cost savings	*Rs/year*	*351167*					

Actual savings are estimated for the same quantity of production (During the energy audit study) with improved load, in order to assess the exact saving potential though the actual production of the furnaces is much higher.

Economics :

Total actual energy savings : 97818 kWh

Actual annual cost savings : Rs. 3.50 lakh

Investment incurred : Nil

Payback period : Immediate

Comparative statement of anticipated and actual energy savings:

Particulars	Units	B3	C1	A2	Total
Estimated loading after improvement	kg	320	277	277	874
Estimated % in improvement in load	%	77	77	77	77
Estimated annual saving in energy	kWh	34460	37270	28170	99900
Estimated annual cost savings	*Rs*	***291000***			
Actual loading after improvement	kg	240	240	640	-
Actual % improvement	*%*	***50***	***50***	***300***	-
Actual energy savings per year	kWh	22950	34408	40460	97818
Actual cost savings	*Rs*	***82390***	***123525***	***145251***	***351000***

It can be seen that though the estimated and actual energy savings are almost same higher cost savings (in excess of 20% of anticipated cost savings) were realised due to increase in power tariff.

Scope for Further Improvement:

The loading in furnaces in B3 and C1 can be improved by additional 20-25% with out any modifications.

RECOMMENDATION : Replacement of Indirect Arc Furnaces with Induction Furnaces

Status : Fully Implemented

Back Ground :

Pefco Foundry had 2 Indirect arc furnaces of capacity 30 kg and 80 kg respectively. These furnaces were used for producing automobile components (Spacer rings, inlet tube and exhaust tubes). The specific energy consumption of these furnaces was :

Specific Energy Consumption, kWh/mt	30 Kg Indirect arc furnace	80 kg Indirect arc furnace
Minimum	1119	3692
Maximum	1258	5068
Average	1158	4448

It can seen that the furnaces were operating at very high specific energy consumption. Hence the audit team had suggested to replace the furnaces with two induction furnaces to reduce the energy consumption.

Action taken by the plant :

Plant personnel have replaced the indirect arc furnaces with one medium frequency (3000 Hz) induction furnace of capacity 125 kW, having two pots 50 kg and 100 kg respectively. The 50 kg pot requires about 90 kW while 100 kg pot requires 125 kW. Actual loading of furnace is 90 kW for 50 kg pot and 125 kW for 100 kg pot. The implementation work was carried out by Pefco in association with the furnace supplier.

Name of the Supplier : Inductotherm, Pune

Investment incurred : Rs 10.00 lakh which includes furnace controls, pots and electrical system and erection charges.

Actual Energy Savings and other benefits achieved:

Actual power consumption and production of the new induction furnace was obtained to evaluate the actual energy savings achieved. While estimating the actual energy savings, the best specific energy consumption value of the old indirect furnace was considered. During post audit review the following were observed:

- *Energy saving potential of 60%*
- *Reduction in specific energy consumption in 30 kg IA Furnace is 40% while 80 kg it is 80%*
- *Better control over the metal composition.*
- *Increased productivity of the furnace by 25% in 100 kg pot and 66% in 50 kg pot*
- *Flexibility and ease in operation*
- *Improvement in working conditions.*
- *Reduction in thermal inertia of the furnace.*

The following table gives the summary of the actual energy savings and other benefits achieved.

Particulars	Units	before (Sep 96) (Indirect arc Furnaces)			After (Sep 97)	Improvement	% Improvement
		30 kg IAF	80 kg IAF	Total/ Ave.	125 kW IF		
Monthly energy consumption	kWh	14434	6280	20714	8267	12447	60
Metal tapped	Kg	13970	2100	16070	13974	-2096	-13
No of heats	No	438	27	465	330	-135	-29
Specific energy consumption per mt	***kWh***	***968***	***2990***	***1085***	***592***	***494***	***60***
Annual energy consumption	kWh	173208	75360	248568	99204	-149364	-60
Cost of energy	Rs	621816	270542	892359	356142	-536217	-60
Annual energy savings	***kWh***	***149364***					
Annual cost savings	***Rs***	***536217***					
Investment incurred	***Rs***	***1000000***					
Payback period	***years***	***1.86***					

Economics :

Total actual energy savings : 1.50 lakh kWh

Actual annual cost savings : Rs. 5.36 lakh

Investment incurred : Rs 10.00 lakh

Payback period : Rs 1.86 years

Comparative statement of anticipated and actual energy savings:

Particulars	Units	Estimated	Actual
Annual cost savings	lakh	1.50	1.50
Annual cost savings	Rs.lakh	4.40	5.34
Investment	Rs lakh	17.50	10.00
Payback period	Year	4.00	1.86

It can be seen that though the estimated and actual heat savings are almost same higher cost savings and very attractive payback period was realised due to:

- *reduction in investment by incorporating single induction furnace with two pots instead of two furnaces.*
- *Raise in power tariff.*

RECOMMENDATION : Reduction in Distribution Losses in Indirect Arc Furnaces

Status : Losses Avoided by replacing the IA furnaces

Back Ground :

Pefco Foundry had 2 Indirect arc furnaces of capacity 30 kg and 80 kg respectively. The estimated Voltage drops and corresponding power losses during energy audit were:

Particulars	Units	30 kg Indirect Arc Furnace	80 kg Indirect Arc Furnace
Voltage Drop	Volt	12.15	4.00
Current	Amps	1281	1467
Power loss per heat	kW	4.40	9.90
Energy loss	kWh/year	27360	5350

In order to reduce the voltage drop and corresponding losses (reduction in losses atleast by 70%), Audit team had suggested periodic cleaning of joints and firm clamping. The estimated savings was

Particulars	Units	30 Kg Indirect arc furnace	80 kg Indirect arc furnace	Total
Energy savings after reducing 70% loss	kWh/year	16630	3740	**20370**
Annual Cost savings	Rs/year	48560	10930	**59490**
Investment required	Rs	10000	10000	**20000**
Payback period	**months**	**3**	**11**	**4**

Action taken by the plant :

Plant personnel have replaced the 2 indirect arc furnaces (which audit team had suggested) with one medium frequency (3000 Hz) induction furnace of capacity 125 kW, having two pots 50 kg and 100 kg respectively. Hence the distribution losses are permanently avoided.

Actual Energy Savings and other benefits achieved:

- Actual cost saving potential after the power tariff hike is Rs 73120 with out any investment, since the cost of induction furnace was considered separately..

The following table gives the summary of the actual energy savings and other benefits achieved.

Particulars	Units	Estimated	Actual	Deviation
Energy savings	kWh/year	20370	20370	**0**
Annual Cost savings	Rs/year	48560	59490	**10930**
Investment required	Rs	20000	0	**-20000**
Payback period	months	4	Immediate	-

Economics :

Total actual energy savings : 0.203 lakh kWh
Actual annual cost savings : Rs. 0.60 lakh
Investment incurred : Nil
Payback period : Immediate

RECOMMENDATION : Use of Existing Single Stage Compressor for Exclusively Cleaning Application

Status : Not Applicable

Back Ground :

The plant had four reciprocating compressors, of which three of them single stage with 140 cfm capacity while the fourth compressor is of 550 cfm capacity. During the normal operation only the fourth compressor is operated. The compressed air is generated 6.2 kg/cm^2g and used for various applications such as moulding, cleaning etc.

During the audit it was observed that cleaning operation was carried out at 6.2 kg/cm^2g. Considering the nature of operation it was felt that compressed air at 2 kg/cm^2g would serve the purpose, hence it was suggested to dedicate one single stage compressor to generated air at 2 kg/cm^2g exclusively for cleaning applications.

Action taken by the plant :

Instead of dedicating one compressor the plant personnel installed a pressure regulating valve at user ends to reduce the consumption of air, since The suggested measure is not economically feasible. During the post audit review the this was discussed in detail. The factors are contributing for non-implementation are:

- *consumption of air for cleaning application is very low i.e., about 50 cfm*
- *allocation of manpower for compressor operation*
- *shortage space required for compressor installation at user end*

Suggestions for improvement:

The compressed air use at for cleaning can be reduce by providing the nozzles to the cleaning hoses. These nozzles have inbuilt pressure regulating valves and air from the nozzle is spread widely to clean the mould effectively. separately. The supplier of such nozzles is :

Concept Pneumatic,
29, 3rd Cross, 11th Main,
4th C Block, Koramangala,
Bangalore-560 034
Ph: 553 3584
Fax: 553 6315.

RECOMMENDATION : Energy savings for lighting circuits

Status : Under implementation

Back Ground :

During the audit it was observed that the voltage level (Single phase) was above 250 V in many in many places of the plant at 19:00 hours. The voltage is bound to go up further during the night time. This in turn reduces the life of the lamps / light fittings & also increases the consumption of more electric power. So it was recommended by the audit team to install Voltage controller / Energy savers. This equipment reduces the voltage and saving upto 20% of the power.

Action taken by the plant :

The plant management has taken earnest steps to implement this proposal. At the request of the management TERI has provided addresses of various parties which manufacture / supply the above equipment. They have spoken with various suppliers. One of the suppliers - Beblec - has agreed to give a demonstration of his product during this month. More ever the plant management has procured and installed 13 nos. of photo sensor switches to operate the out-door lighting circuit.

Revised Economics.

Proposal	Energy saved kWh/yr	Cost of energy saved Rs/year	Investment required Rs.	payback period Years
Energy savers for lighting circuits	10278	36898	51970	1.408

It can be observed that the price of the equipment has remained constant, but with the increase in the cost of electricity the pay back period has come down from 1.73 years to 1.4 years and hence making the proposal more attractive.

5.0 ENERGY CONSERVATION MEASURES INTIATED AND IMPLEMENTED BY THE PLANT

Plant personnel have identified and implemented some energy conservation measures. This section covers the study of energy conservation measures adopted by the plant.

- *Incorporation of intelligent programmable logic controllers for heat treatment furnaces.*
- *Installing lighting sensors.*
- *Rectifying the soft starter installed for the compressor.*
- *Estimation of transformer losses and corrective action taken to reduce the losses.*
- *Complete replacement of the heat treatment furnace.*

In addition plant management are continuously looking out for energy conservation measures

6.0 ASSISTANCE PROVIDED BY TERI

TERI after conducting the post audit review has at the request of plant management, provided the name and addresses of supplier of various retrofits as well as successful case history of the recommendations. In addition to this revised techno-economics was carried out for all non-implemented proposals.

7.0 SUMMARY OF ANNUAL SAVINGS ACHIEVED

Energy Conservation Measure	Energy Savings kWh/year	Cost savings Rs Lakh/year
Transformer load management	53940	2.10
Use of energy efficient motor	4820	0.17
Replacement of refractory with ceramic fibre in heat treatment furnaces	97100	3.50
Improvement in Loading of heat treatment furnaces	97800	3.50
Replacement of Indirect arc furnaces with induction furnaces	150000	5.36
Reduction in distribution losses in Indirect arc furnaces	20300	0.60
	423960	15.23

8.0 ENERGY MANAGEMENT SYSTEMS

8.1 *ENERGY MANAGEMENT SYSTEM*

Energy Data Collection and Analysis

* maintain records of all energy consumption in the plant.

* check the reading of all meters and submeters on a regular basis.

* specify additional meters required to provide additional monitoring capability.

* develop indices for specific energy consumption relative to production and maintain these indices on a monthly basis for all major production areas.

* set performance standards for efficient operation of machinery and facilities.

Energy Purchasing Supervision

* review all monthly utility and fuel bills ; ensure billing is proper and that the optimum tariff is applied in each base.

* investigate and recommend fuel switching opportunities where a cost advantage to the company is possible.

* develop contingency plans to implement in the event of supply interruptions or shortages.

* work with individual departments to prepare annual energy cost budgets.

Energy Conservation Project Evaluation

* develop energy conservation ideals and projects, working with in-house staff, equipment vendors and outside consultants.

* summarize and evaluate possible energy saving projects according to the company financial planning requirements ; perform the necessary economic analyses to permit management evaluation of the projects.

* obtain management commitment of funds to implement conservation projects.

* re-evaluate possible projects as the company operations change or grow; evaluate energy efficiency of new construction, building expansion or new equipment purchases.

Energy Project Implementation

* initiate equipment maintenance programmes for energy saving

* supervise the implementation of conservation projects, including specification of equipment, requests for quotation, evaluation of offers, ordering of materials, construction/installation, operator training, start-up and final acceptance.

Communications and Public Relations

* prepare monthly reports to management, summarizing monthly energy costs and consumption as well as specific energy consumption.

* communicate with all production and support departments, so that all participate in the energy management programme.

* develop an awareness programme within the company to encourage active participation by all employees in energy saving activities.

* develop training programmes to upgrade knowledge and skills of all levels of employees in energy related matters..

* publicise the company commitment to energy conservation where appropriate, providing information for press releases and internal notices, presenting papers in professional conferences, and entering the company in energy award programmes.

8.2 *CHECKLIST FOR TOP MANAGEMENT*

A. Inform line supervisors of :

* The economic reasons for the need to conserve energy.

* Their responsibility for implementing energy saving actions in the areas of their accountability.

B. Establish a committee having the responsibility for formulating and conducting an energy conservation programme and consisting of :

* Representatives from each department in the plant

* A co-ordinator appointed by and reporting to management.

C. Provide the committee with guidelines as to what is expected of them :

* Plan and participate in energy saving surveys.

* Develop uniform record keeping, reporting and energy accounting.

* Research and develop ideas on ways to save energy.

* Communicate these ideas and suggestions.

* Suggest tough, but achievable, goals for energy saving.

* Develop ideas and plans for enlisting employee support and participation.

* Plan and conduct a continuing program of activities to stimulate interest in energy conservation efforts.

D. Set goals in energy saving :

* A preliminary goal at the start of the programme.

* Later, a revised goal based on savings potential estimated from results of surveys.

E. Employ external assistance in surveying the plant and making recommendations, if necessary.

F. Communicate periodically to employees regarding management's emphasis on energy conservation action and report on progress.

8.3 DUTIES AND RESPONSIBILITES OF ENERGY MANAGER/CO-ORDINATOR

* To generate interest in energy conservation and sustain the interest with new ideas and activities.

* To maintain summaries of energy purchases, stocks and consumption, and to review and report on energy utilisation regularly.

* To be the focal point for departmental records of energy use, and to ensure that the records and accounting systems are uniform and in consistent units.

* To co-ordinate the efforts of all energy users and to set challenging but realistic targets for improvements.

* To give technical advice on energy-saving equipment and techniques, or to identify suitable sources of sound technical guidance on specialised subjects.

* To identify areas of plant activity which require detailed study and to give priority to such activities.

* To maintain records of all-in-depth studies and to review progress.

* To provide a basic handbook of good energy practice for the plant operating department.

* To give specialist advice to purchasing, planning, production and the other functions of all aspects of energy conservation, especially on the long term implications.

* To ensure that, in making improvement in energy efficiency, health and safety are not adversely affected.

* To liaise with committees and working groups within his own industry, and provided no confidential data are involved, to exchange ideas on cost cutting techniques and performance figures for similar processes.

* To maintain contacts with research organisations, equipment manufacturers and professional bodies to ensure that he is up-to-date on significant developments in the field of energy conservation.

* To remain up-to-date on national energy matters and to advise senior company management on such topics, as well as co-operating with government departments in energy-related matters.

9.0 CONCLUSIC N AND ACKNOWLEDGEMENT

The post audit review for the energy audit conducted during November 1997 at Pefco Foundries, Pune has been discussed in detail. It is observed that about 80% of measures suggested by TERI has been implemented by the plant management.

The post audit review team would like to place on record our grateful thanks to Mr. R K Saboo, General Manager-Commercial, MR J V Patankar; General Manager-Works and Sales and Mr V B Shardul; Manager- Maintenance and other plant personnel for the co-operation and the assistance extended to us during post audit review discussions.

APPENDICES

APPENDIX - 1

Transformer Load Management

Transformer : 3 (Feeding Unit II Auxiliaries) - 800 kVA

Sl No	Load Details	Dec 1995 (before audit)	Nov 1997 (after audit)
1	Baling Press	50	50
2	Charge Compacting m/c 's	30	30
3	Sand Plant & drives	150	150
4	Fur. Water pumps & C.T. pumps	50	50
5	Lighting	20	20
6	Compressor (shifted after audit due to recommendation)		100
	Total Load	300	400

Analysis of Transformer performance

Data (Transformer reading collected on 19 /11/97 @ 11:30)

	Volts	Amps	Freq.	p.f.	kVA	kW
R* - phase	232	247	50.9	1.00	39.2	38.4
Y* - phase	280	248	50.9	0.95	40.7	39.3
B* - phase	270	249	50.9	0.99	45.5	45.4
Total					125.4	

* - Single phase readings

Data	Unit	Before Audit	As per rec.	Actual after imple.
Maximum load (peak load)	kVA	300	500	400
Loss load factor		0.75	0.75	0.5016
No load losses (annual)	kWh	13140	13140	13403
Load losses (annual)	kWh	6238	16875	729
Total losses (annual)	kWh	19378	30015	14132

Appendix - 1 contd.

Average load is taken as 60% more than the measured value due variation in the product profile.

Average load	=	1.6 * 125.4 = 200.64 kVA
Load factor	=	Average load / Peak load.
	=	200.64 / 400
	=	0.5016
Load loss factor	=	$(\text{load factor})^{1.5}$ = $(0.5016)^{1.5}$
	=	0.3552
Annual load loss	=	365 * 24 * $(\text{Actual power/ Rated power})^2$ * Short circuit loss * l.l.f. * utilisation factor.
	=	365 * 24 * $(125.4 / 800)^2$ * 9.53 * 0.3552
	=	728.59 ≈ 729 kWh

Actual reduction in loss	=	Energy saved
	=	5246 kWh
Cost of energy saved	=	Rs. 18,833 /-

Appendix - 1 contd.

Transformer : 4 (Feeding Unit I Auxiliaries) - 1000 kVA

Sl No	Load Details in kVA	Dec 1995 (before audit)	Nov 1997 (after audit)
1	Electrotherm	380	380
2	Direct arc furnace #	250	250
3	Indirect Arc furnace 2 x 30 kg	200	
4	Indirect Arc furnace 1 x 80 kg	200	
5	Aux plant load in Unit m/c shop	40	40
6	Compressor	100	
7	Induction furnace (in place of IAF)		140
	Total Load	950	560

Operates once a week , hence not considered for performance calculation.
Analysis of Transformer performance

Data (Transformer reading collected on 19 /11/97 @ 11:30)

	Volts	Amps	Freq.	p.f.	kVA	kW
Tr # 4	440	504	51.1	0.9	130	120
Total					130	

Data	Unit	Before Audit	As per rec.	Actual after imple.
Maximum load (peak load)	kVA	950	750	560
Loss load factor		0.75	0.75	0.2263
No load losses (annual)	kWh	18396	18396	18396
Load losses (annual)	kWh	55143	28249	1038
Total losses (annual)	kWh	73539	46644	19434

Average load is taken as 60% more than the measured value due variation in the product profile.

Appendix - 1 contd.

Average load = 1.6 * 130
= 208 kVA

Load factor = Average load / Peak load.
= 208/560
= 0.3714

Load loss factor = $(\text{load factor})^{1.5} = (0.3714)^{1.5}$
= 0.2263

Annual load loss = 365 * 24 * (Actual power/ Rated power) ^{2} * Short circuit loss * load loss factor * utilisation factor.

= 365 * 24 * (130 / 560) ^{2} * 12.25 * 0.2263

= 1308 kWh

Actual reduction in loss = Energy saved
= 54105 kWh

Cost of energy saved = Rs.1,94,237 /-

REVISED MOTOR PERFORMANCE CALCULATIONS

Sl. No.	APPLICATION	ACTION TAKEN AFTER AUDIT	RATING kW	MEASURED kW	OPER. EFFIC. %	OPERT LOSSES OLD	REDUC. IN LOSSES	ANNUAL OPERT. HRS	SAVINGS IN kW	COST SAVINGS Rs
1	Blower motor		18.5	14.40	80.07%	2.87				
2	Blower motor Revised	Location of the motor changed	18.5	9.51	76.42%	2.24	0.63	7200	4536	16284
3	Centrifugal liner (Big)		11.0	4.59	73.09%	1.23				
4	Centrifugal liner (Big) Revised	Reduction in operating hours	11.0	5.58	76.24%	1.33	-0.10	750	-75	-129
5	Sand mixer		15.0	12.00	82.25%	2.13				
6	Sand mixer Revised	Change in the process	15.0	11.64	82.15%	2.08	0.05	7200	360	619

Cost of investment - Nil
Payback period - Immediate

APPENDIX - 3

REVISED LOADING PATTERN OF MOTORS

SL. No.	APPLICATION	RATING kW	MEASURED VALUE kW		% LOADING PATTERN	
			BEFORE	AFTER	BEFORE	AFTER
1	Sand Cooler	7.5	2.64	1.50	35.39	20.11
2	Knock out motor	5.5	0.90	1.26	16.36	22.91
3	Alex m/c	3.7	0.45	1.23	12.16	33.24

APPENDIX - 4

Section : Heat treatment furnaces

ECO : REPLACEMENT OF THE REFRACTORY WITH CERAMIC FIBRE INSULATION

Furnace refractory insulation was replaced with ceramic fibre in combination with refractory bricks Surface Heat Losses After Ceramic Fibre Insulation

Furnace # B3

Particulars	Area, m^2	Temp., ^0C	Total Heat Loss, kcal/h	Temp before insulation ^0C	Losses Before insulation kCal/h	Reduction in heat loss kCal/h	% reduction in loss
Front							
Segment 1	0.35	59	81	111	318	237	74
Segment 2	0.35	96	224	124	385	161	42
Segment 3	0.35	70	120	115	336	216	64
Segment 4	0.35	75	138	110	312	174	56
Total			563		1351	788	58
Top							
Segment 1	0.81	50	138	102	707	569	80
Segment 2	0.76	51	142	88	540	398	74
Total			281		1247	966	77
Bottom							
Segment 1	0.81	61	170	85	509	339	67
Segment 2	0.81	65	197	82	438	241	55
Total			367		947	580	61
RHS							
Segment 1	0.76	68	244	104	610	366	60
Segment 2	0.76	58	169	88	443	274	62
Total			413		1053	640	61
LHS							
Segment 1	0.76	61	191	97	528	337	64
Segment 2	0.76	58	169	93	497	328	66
Total			360		1025	665	65
Back Side							
Segment 1	0.705	83	341	95	477	136	28
Segment 2	0.705	73	263	95	477	214	45
Total			605		954	349	37
Grand Total			**2589**		**6600**	**4011**	**61**

Appendix - 4 contd..

Summary of Furnace B3 :

Surface Heat Losses Before Insulation	: 6600 kCal/h
Surface Heat losses after insulation	: 2589 kCal/h
Reduction in surface heat losses	: 4011 kCal/h
Percentage reduction	: 61%
Savings in power	: 4.7 kWh
Cycle time before insulation revamping	:18 h
Cycle time after insulation	: 11 h
Reduction in cycle time	: 6.5 h
Savings due to reduction in surface losses	: 24485 kWh/year
Savings due to reduction in cycle time	: 13642 kWh/year
Total energy savings	: 38127 kWh/year
Annual Cost Savings	: Rs. 137258
Investment Required	: Rs. 100000
Payback Period	: 0.73 years

Appendix - 4 contd..

Furnace # C1

Actual Energy Savings after revamping the furnace insulation

Particulars	Area, m^2	Temp., ^0C	Total Heat Loss, kcal/h	Temp before insulation ^0C	Losses Before insulation kCal/h	Reduction in heat loss . kCal/h	% reduction in loss
Front							
Segment 1	0.35	62	91	111	318	227	71
Segment 2	0.35	60	85	124	385	300	78
Segment 3	0.35	65	102	115	336	234	70
Segment 4	0.35	100	241	110	312	71	23
Total			519		1351	832	62
Top							
Segment 1	0.81	53	163	102	707	544	77
Segment 2	0.76	48	119	88	540	421	78
Total			282		1247	965	77
Bottom							
Segment 1	0.81	74	260	85	509	249	49
Segment 2	0.81	69	224	82	438	214	49
Total			484		947	463	49
RHS							
Segment 1	0.76	49	107	104	610	503	82
Segment 2	0.76	48	100	88	443	343	77
Total			207		1053	846	80
LHS							
Segment 1	0.76	55	148	97	528	380	72
Segment 2	0.76	53	134	93	497	363	73
Total			282		1025	743	73
Back Side							
Segment 1	0.705	68	226	95	477	251	53
Segment 2	0.705	69	234	95	477	243	51
			460		954	494	52
Grand Total			2235		6600	4365	66

Appendix - 4 contd..

Summary of Furnace C1

Surface Heat Losses Before Insulation	: 6600 kCal/h
Surface Heat losses after insulation	: 2235 kCal/h
Reduction in surface heat losses	: 4365 kCal/h
Percentage reduction	: 66 %
Savings in power	: 5.1 kWh
Cycle time before insulation revamping	: 18 h
Cycle time after insulation	: 11 h
Reduction in cycle time	: 6.5 h
Savings due to reduction in surface losses	: 26647 kWh/year
Savings due to reduction in cycle time	: 13461 kWh/year
Total energy savings	: 40108 kWh/year
Annual Cost Savings	: Rs.144389
Investment Required	: Rs. 100000
Payback Period	: 0.69 years

Overall Summary

Actual Energy Savings after revamping the furnace insulation

Summary	Units	B3	C1	A2	Total
Surface Heat Losses Before Insulation	kCal/h	6600	6600	4504	17704
Surface Heat losses after insulation	kCal/h	2589	2235	2462	7286
Reduction in surface heat losses	kCal/h	4011	4365	2042	10418
Percentage reduction	%	61	66	45	59
Savings in power	kWh	4.7	5.1	2.4	12.1
Cycle time before insulation revamping	h	17.5	17.5	16.0	17.0
Cycle time after insulation	h	11	11	9	10.3
Reduction in cycle time	h	6.5	6.5	7	6.7
Savings due to reduction in surface losses	kWh/year	24485	26647	11397	62530
Savings due to reduction in cycle time	kWh/year	13642	13461	7479	34582
Total energy savings	kWh/year	38127	40108	18877	97112
Annual Cost Savings	Rs	137258	144389	67767	349414
Investment Required	Rs	100000	100000	200000	400000
Payback Period	years	0.73	0.69	2.95	1.14